Original Article

Primary prevention of deep venous thrombosis and pulmonary embolism in acute spinal cord injured patients

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Study design: Prospective clinical trial.

Objectives: To evaluate the efficacy of a specific protocol for prevention of thrombo-embolic disease occurring during the acute stage of spinal cord lesions, based on the simultaneous use of pharmacological plus mechanical procedures.

Setting: Regional Spinal Unit of Florence, Italy.

Introduction: Deep venous thrombosis (DVT) is a dangerous pathology whose first clinical sign can be represented by unexpected pulmonary embolism (PE). Its incidence in acute spinal cord injured (SCI) patients is reported to range between 9% and 90%. Its prevention represents one of the major challenges for the clinicians involved in the care of such patients.

Method: Two hundred and seventy-five SCI patients consecutively admitted to our Centre were investigated by colour doppler ultrasonography of lower limbs and pelvis on admission, after 30–45 days and whenever clinically requested. Subcutaneous Nadroparine, a low molecular weight heparin (LMWH), plus early mobilisation, permanently dressed gradient elastic stockings (PGES), and external sequential pneumatic compression (ESPC) of the lower limbs, applied during the first 30 days after injury, were given to all of them. Colour doppler ultrasonography (CDUS) complete investigations of the lower limbs and pelvis were performed on admission, after 30–45 days and whenever clinically requested. The patients were divided into two groups according to their time interval from injury to the admission to our Centre.

Results: The incidence of detected DVT was 2% in those patients (99) admitted early to our centre (within 72 h from the trauma), who immediately received our prophylactic protocol. No PE was reported. The other group of patients (176), all admitted between 8 and 28 days (mean 12 days) developed DVT in 26% of cases. None of these patients received ESPC before being admitted to our Centre. No patient had been admitted between 3 and 8 days interval time post injury.

Conclusion: Early application of pharmacological plus mechanical treatment for DVT prevention produces a marked reduction in such complications. It also reduces the risks of morbidity and mortality in our patients, and, not least, reduces the hospitalization costs during the early period of rehabilitation.

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Keywords: acute spinal cord injury; deep venous thrombosis prophylaxis; low molecular weight heparin; external sequential pneumatic compression; colour doppler ultrasonography

Introduction

Deep vein thrombosis (DVT) represents one of the most common and dangerous complications during the acute stage of spinal cord injuries (SCI),^{1,2} reported to

occur mainly during the first 2 weeks after injury. It represents the first step towards pulmonary embolism (PE) which is still a leading cause of death.^{3–5}

Incidence of DVTs in medical reports are extremely variable, ranging from 9% to 90%.^{6–15} Nevertheless, in more recent and widespread studies, it is reported to vary between 10% and 30%.^{16–21}

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With regard to the diagnosis it has been noted that colour doppler ultra sonography (CDUS) is a more available, more economical, more repeatable and a less invasive method compared to phlebography, and it is considered to be the gold standard diagnostic procedure due to its sensitivity and precision.^{22,23,25}

The high risk of DVT in acute SCI patients is due to the simultaneous presence of the three factors of the Virchow's triad: *hypercoagulability*, *stasis*, and *intimal injury*, as stated by Hachen *et al.*,²⁴ Myllynen *et al.*¹⁰ and Mammen.³³

Different ways of prevention have been proposed, with different results: subcutaneous administration of calcium heparin, low molecular weight heparin (LMWH)²⁷⁻²⁹ and low oral dose of dicoumarol are widely used.³⁰ Anti aggregation agents such as aspirin or dipyridamole did not prove to give satisfactory results, when given alone.¹¹

Permanently dressed gradient elastic stockings (PGES) seem to give good results by increasing venous outflow.³²

Electrical stimulation applied to the lower limbs has been reported to give some benefit by achieving active muscular contraction and improving venous flow; an enhancement of systemic fibrinolytic activity was also reported.³¹

The combination of different prophylactic treatments appear to give better results in preventing DVT during the acute stage of SCI.

A retrospective analysis conducted on 492 patients admitted to our centre from January 1979 till December 1995 showed a DVT incidence in the acute stage of 9% in those admitted between 1979 and 1991 (362 patients), when the investigation was performed by clinical examinations followed by venography when clinical evidence was present. DVT incidence rose to 27% in those patients admitted between 1992 and 1995 (130 patients), when all patients were routinely investigated by CDUS on admission, then 30 to 45 days after the lesion and whenever clinically requested. Prophylaxis was homogeneous for all of the 429 patients. The incidence of PE in the first group was 4.3%, that was fatal in 3.5%. PE mostly occurred in undiagnosed DVT and asymptomatic patients, between 15 and 90 days post injury.

In the second group the incidence of PE was 0.77% (1 patient) with no fatal case. Clinical evidence of DVT was present only in 8% of the total investigated population.

By this experience it would appear that a routine CDUS examination might dramatically reduce the incidence of PE together with its mortality rate, by achieving a very early diagnosis of DVT, before any clinical evidence. On the other hand we realized that the real incidence of DVT in acute SCI was very high, reaching 27%, when prophylaxis was performed by giving subcutaneous calcium heparin plus early mobilization of lower limbs and PGES.

A similar trend of incidence of thrombotic pathology has been reported also by Winemiller in 1999.¹⁸

Even in that study the progressive increase in incidence was attributed only to a better capability in diagnosing it. From October 1995 we started to adopt a combined approach to prevent DVT, based on the simultaneous use of low molecular weight heparin and external sequential pneumatic compression applied on both the lower limbs.

Methods

All patients affected by acute SCI consecutively admitted to our Centre between January 1st 1996 and May 15th 2000 (275 patients) were investigated by CDUS of lower limbs and pelvis to detect the presence of DVT. The examinations were performed immediately on admission, after 45 to 60 days and then whenever clinically requested. The prophylactic treatment was based on the combined use of mechanical plus pharmacological agents and it was given to 99 patients within 72 h (EAP=Early Admitted Patients), while the other group of 176 patients (LAP=Late Admitted Patients), did not receive the same treatment from the very early stage, but started it from their date of admission, in a period ranging from 7 days to 28 days post injury (mean 12 days).

Inclusion criteria of patients into this study were the following:

- All acute traumatic SCI patients consecutively admitted to our Centre with motor complete and incomplete lesions (ASIA A to D).
- Absence of contra-indications to heparin and/or to mechanical prophylaxis.

Exclusion criteria:

- Formerly known abnormalities of any coagulation factor,
- Any contra-indications to heparin or to lower limb mechanical compression.

Our protocol of DVT prevention was:

- PGES
- Subcutaneous LMWH (nadroparine) 0.4 ml once a day
- ESPC of the lower limbs 3 h per day given in two applications.
- Early mobilisation of the lower limbs.

This complete prophylactic treatment lasted at least 30 days from injury, and it was continued only by the application of LMWH and ESPC for two more months according to the patients' progress.

LAP had access to our Centre in an average period of 12 days post trauma, due to the acute treatment performed elsewhere. These patients received in our Centre either the same prophylactic treatment, if no clot had been detected on admission, or the therapy to

counteract the eventually detected thrombus (warfarin alone or in association with caval filter). None of these patients had been receiving EPSC as a prophylactic measure in their previous hospitalisation.

Results

The results are summarised in Tables 1 and 2. DVT incidence in Early Admitted Patients was 2%. In fact only two cases were recorded, both males, one paraplegic ASIA B and the other tetraplegic ASIA C. Those two cases were both detected by CDUS performed on clinical evidence, respectively 25 and 29 days after injury. In one case DVT was just located at popliteal level.

The group of Late Admitted Patients was statistically similar to the group of Early Admitted Patients regarding age, sex, neurological level and ASIA impairment scale and associated injuries. Fisher Exact Test was used for statistical analysis, and results were considered significative when P was 0.1.

The incidence of DVT in Late Admitted Patients was 26%. Of those 60% were detected on admission, while the remaining 40% developed in a period not exceeding 6 weeks of hospitalisation. Sixty-five per cent of detected DVT did not show any evident clinical sign. Asia A were more likely to develop DVT

(36%), while in ASIA D on admission only 7% did so. No PE was recorded.

Discussion

A more accurate investigation, such as routine and repeated CDUS in the acute phase, will give a more accurate incidence of DVT. A more accurate investigation may also lead to a more efficient primary prevention of PE, that appears to be a direct consequence of an undiagnosed DVT. In fact, in our study, clinical evidence of DVT was relatively rare, being present in 9% of cases (about 35% of the total DVTs). In other words, the routine investigation by CDUS of lower limbs and pelvis may detect DVT before any clinical evidence, and thus lower the risk of embolism.

Regarding EPSC, the device we have adopted and which has given such positive results is a programmed one, consisting of five contiguous, sequential, pneumatic chambers that cover the foot and the leg. Pneumatic compression is bilaterally applied in sequence, starting from the foot and reaching the proximal area of the lower limb. In every chamber the maximal pressure does not exceed 50 mmHg.

Each compression cycle lasts 90 s with 30 s sequential compression (30 s the first chamber, 24 s the second, 18 s the third and so on) and 60 s deflation time to allow blood flow.

The application of EPSC should not exceed 3 h a day, given in two separate applications daily, in order to avoid further damage to the vessels. Even if it is not statistically correct to compare the two groups of patients for the lack of homogeneity of treatment (the second group had been treated in other hospitals for an average period of 12 days), the important reduction of incidence of DVT using our protocol is considered an important result.

Conclusion

In our study the adoption of a combined approach in DVT prevention that includes LMWH, EPSC and routine plus 'on demand' use of CDUS of the lower limbs together with traditional measures (early mobilisation, PGES, clinical and haematological examinations), has dramatically reduced thrombo-embolic disease.

The prophylactic treatment should start during the very early stage post trauma (within 24–72 h) after a requested CDUS examination. We cannot state which one of the two factors of our treatment protocol (LMWH and EPSC) is more important in influencing the results or if the combination of the two is necessary. Further studies will be necessary to give a better understanding of these results. Routine and demand CDUS investigation of lower limbs however revealed this to be an efficacious tool in primary PE prevention.

Finally our study demonstrates the necessity of early admission to Spinal Units for SCI persons to better prevent complications.

Table 1 EAP: early admitted patients: within 72 h from trauma

	Number		DVT	
Total	99	100%	2	2%
Male	79	79%	2	2.5%
Female	20	21%	0	0%
Paraplegia	58	58%	1	1.7%
Tetraplegia	41	42%	1	2.4%
ASIA A	33	33%	0	0%
ASIA B	25	24%	1	4%
ASIA C	20	21%	1	5%
ASIA D	15	15%	0	0%
Mean age	41.3			

Table 2 LAP: late admitted patients: average admission time 12 days

	Number		DVT	
Total	176	100%	46	26%
Male	142	81%	43	30%
Female	34	19%	3	9%
Paraplegia	98	56%	27	27%
Tetraplegia	78	44%	19	24%
ASIA A	67	38%	24	36%
ASIA B	44	25%	12	27%
ASIA C	36	21%	8	21%
ASIA D	29	16%	2	7%
Mean age	42.3			

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